The Combination of Renewable Energy Effective Use and Architecture Design

Yi Zhou
Master
Kunming University of Science and Technology
Kunming P.R.China
Juliazhou_66@yahoo.com.cn

Abstract: Through introducing the renewable energy and its characteristics, it is illuminated that renewable energy use has much superiority. At the same time, through introducing renewable energy technology, which is used in architecture, and elaborating on the form in which renewable energy is combined with architecture, this paper expresses the architectural design concept that architectural design should be organic and unified with renewable energy use.

Key words: renewable energy; solar energy; wind energy; tromber wall; sustainable development

0. INTRODUCTION

The existence of architecture is in order to satisfy people's survival and the development. With the rapid development of Chinese economy, it is unprecedented prosperity in the construction market. From The National grand Theater (designed by Paul. Andreu) to The Olympic Stadium "nest"(cost 3.1 billion RMB), and especially the CCTV Tower (designed by Rem Koolhaas), most of modern Chinese buildings are in the building shapes and styles as the starting point to design. People seem to forget that the significance of architecture existence is in order to meet human's need, guarantee people's survival and the development. Pursuing novel shapes seems to have become the mainstream of architecture design. But this kind of buildings consumes a great deal of energy to the Earth.

Nowadays, the serious problem, which is faced with by china is that the resources are extremely insufficient, for example: the petroleum, the electric power, the land and the water resources and so on. However, China's energy consumption of construction is extremely astonishing. Recently from the Ministry of Construction noted that the energy consumption of buildings in China alarming, building construction and the use of direct and indirect energy consumption by society as a whole accounted for *46.7%* of total energy consumption. And which is largely due to the design, construction only attention to the form, not taking into account the energy-saving design. Therefore, the effective use of renewable energy and building design should be combined organically.

1. RENEWABLE ENERGY

1.1 Definition

Renewable energy is the clean energy, which can be constantly updated and continually used. It is harmless or harm minimum for the nature environment. Moreover, its resources are widely distributed, so that is fit for using in local. The renewable energy mainly includes solar, wind, water, biomass, geothermal and ocean energy, and other non-fossil energy.

1.2 Typical characteristics of renewable energy

1.2.1 solar energy

Solar energy is not only a kind of primary energy, but also a renewable energy. Its advantages are: rich in resources, convenient for using, no pollution, and without transport. But it has two main disadvantages: one is that energy flux density is slow; the other is that the energy's intensity, which is affected by various factors (season, location, climate, etc.) can not maintain the constant.

1.2.2 wind energy

Wind energy is a kinetic energy, which is generated by the air transport. Four major advantages are: 1, abundant in quantity; 2, renewable; 3, widespread distribution; 4 no pollution. Three major weaknesses are: 1,low-density; 2, unstable; 3, Large regional differences.

1.2.3 water energy

Water energy refers to the kinetic energy, potential energy and pressure energy of water body. Its main traits are: it is rich, recycled, but distributes unevenly, and is affected by the season and weather.

1.2.4 biomass energy

Biomass energy is fixed form energy. It stores solar energy through plant photosynthesis. And it includes crop residues, wood processing waste, livestock waste, industrial organic waste, and urban living refuses, etc. Its main features are: rich, can be stored and transported, and low in oxide of nitrogen (N) and sulphur (S). Accordingly, using 10,000 tons of straw to replace burning fuel can reduce the discharge of CO_2 14,000 tons, SO_2 40 tons, and dust 100 tons.

2. RENEWABLE ENERGY APPLICATIONS IN BUILDINGS

2.1 The Application of Solar Energy in Buildings

Solar energy can be directly converted into light and heat. It is the most commonly using energy of buildings.

2.1.1 solar water heater

Fig.1 Combination with roof

Solar water heater is primarily to the use of solar thermal energy. At present the solar water heater basically divides into 3 types: flat plate solar water heater, glass vacuum tube water heater and integral collector storage water heater. The main applications of solar water heaters in the architectures are:

(1), Roof-way, the form is combination with roof. And it is the most common form (Figure 1). The key is to manage well the contradictions of the roof slope and water heaters' inclination.

(2), Balcony-way is a more novel way and can be better combine with building's figure. The balcony slab is made a certain angle. And its upside lays the solar water heaters, which provide users with hot water. This way is always for multi-layer and high-rise residence. The key is to deal with well the problem about the long pipeline.

(3), Awning-way, that is put the solar water heater on the awning, is able to not only collect solar energy, but also shade strong sunlight in the room. But it has more problems in combination with the architectural design. And people are more and more pay attention to this form.

(4), Wall-type, is put the thermal collector vertical or level on the surface of outside walls. The solar collector is no more the supplementary, but a part of architectures. This technology has been use in Germany only.

(5)、Free-style, breaks the traditional concept of water heater. This method improves the tech-level of water heater. Also, the water heater becomes the free component of architecture.

2.1.2 solar house

The solar thermal energy and solar light energy are mainly used in solar houses. It is divided into passive solar houses and active solar houses.

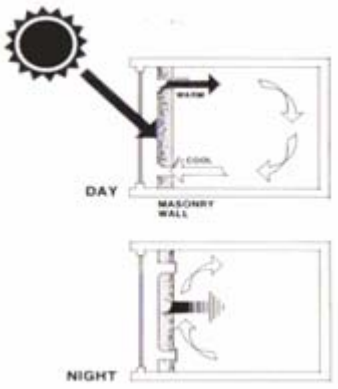

Fig.2 Trombe Wall

The principle of passive solar house is setting a storage, which has more thermal capacity in the buildings, through controlling the storage's changes, to getting the effect of heating or refrigerating. Design attentions: direction of buildings, internal structure, external size and choice to the construction material of buildings. The form of buildings can be changeable. But safeguarding structures must be good heat insulation performance. There are four kinds.

(1). Receives the solar radiant energy directly. There should be certain areas of glazing and collector in the buildings. Then it can keep the temperature.

(2).Trombe Wall, A Trombe wall consists of a vertical dark wall (*240-400mm*), built of a material such as

stone, concrete, or adobe that is covered on the outside with glazing (distance between wall and glazing is *100-150mm*). Sunlight passing through the glazing generates heat, which conducts through the wall. Warm air between the glazing and the Trombe wall surface can also be channeled by natural convection into the building interior or to the outside, depending on the building's heating or cooling needs. (Figure2)

Fig.3 Sunshine room

(3). Sunshine room (Figure3), usually setting in the south of the building (terrace, gallery, porch), is mainly composed of enclosing glazing and heat storage body. When there is sunshine in this room, one part of solar energy is stored; the other is organized to enter the interior. This method can improve the condition of interior, but also should be pay attention to the problem of heat losing by large area glass. So, it must set insulating layer to cover the glasses. For keeping drafty in summer, the windows in sunshine room should be able to open completely.

(4). Cistern on the roof. The goal of laying a water tank or water bags is heat absorption and heat storage. On the top of the cistern, it should set a cover, which can easily open. This method is simple-design and comfortable –condition. But the problem is: the roof load is too heavy; and must consider the waterproof measure. Therefore, it should be continually ameliorate.

Active solar houses are utilizing motility to carry on thermal cycle of heating or cooling. Active solar system includes heat collector, heat storage, heat exchange, circulation pump, donkey boiler, connecting, and automatically controlled equipment. Its advantages are high in efficiency to collect heat at low temperature, little of defenses in temperature between day and night. But there must be measure of preventing frostbite. There are three kinds of this kind of building: 1.Supplied by hot wind. 2. Supplied by hot water. 3.solar air-condition. In addition, it generally considered boiler room in architecture design of active solar energy system.

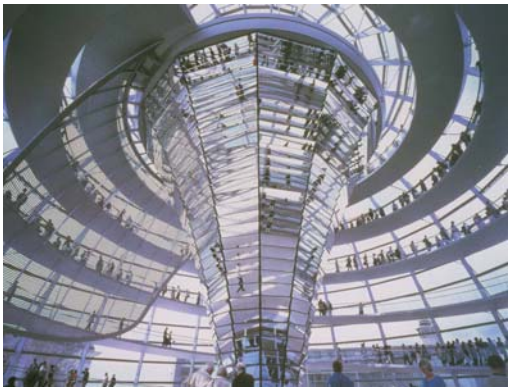

Fig.4 Berlin Congress building

2.1.3 the application of solar light in architecture

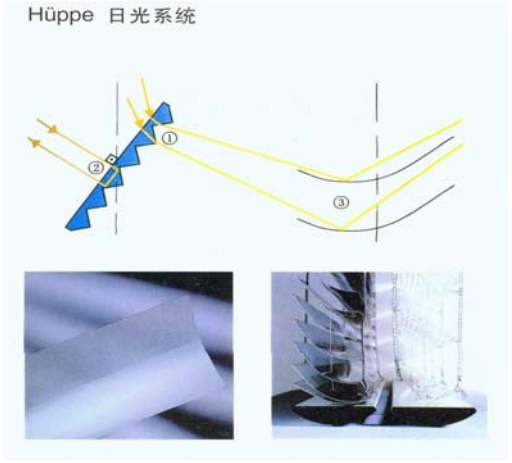

Fig.5 Hüppe solar system

The natural lighting may save the electrical energy, so the natural lighting should be considered as far as possible in the architecture design. The skylight can be used in the great span constructions, for example: The reconstruction of Berlin Congress building (Figure 4) has used the glass vault. And there is a cone with mirror-surface, which can reflect the incident sunlight, and a sunshade, which automatically moves along with the sun path to prevent high temperature and strong sunlight.

At the same time, we can develop the detail structures to adequately utilize natural light. Figure 5 is the Hüppe system developed by Hüppe Form GmbH. the diffuse reflecting light can enter into the room. the direct sunlight can be reflected. Through refraction, the light can go into the deep place of the room.

2.2 The Application of Wind Energy in Buildings

Generally speaking, the wind energy is also solar energy. Because of the sun shining, the temperature rising, bringing the temperature difference, the density contrast, and the pressure difference, it forms air transport. Ventilating is absolutely necessarily in architectures. It can bring us fresh air, cool feeling, no bug and comfortable environment.

Today, the air condition-tech is more and more used in buildings to satisfy the requirement of ventilation, temperature and humidity. It seems to be a respiratory organ. But, once there was no electricity, the organ would not use. So making wind by space design can not only save energy, but also bring amazing artistic effect.

The principle of using wind in architecture is: making wind for using it. For example, Figure 6～7 is

Fig.6 Sunshades

French State-run Senior middle school. There are clerestories on the middle top of the building and sunshades, which are on the top of sunny side windows where are many trees. The hot air rises and discharges from the clerestories. It forms nicer wind.

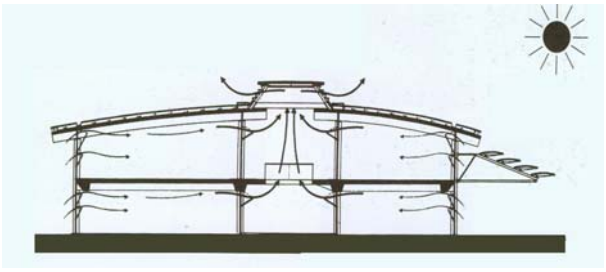

Fig.7 Section plane and air organization

The natural ventilation system of Berlin Congress building is also an extremely ingenious design (Figure 8). It is using the effect of the chimney.

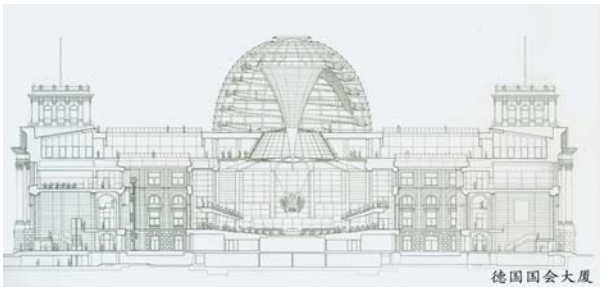

Fig.8 The sketch map of Berlin Congress building

2.3The using of the water resource

The using of the water resource in architecture is on everywhere (living water, drinking water, fire water and environment water). Although the water resources are the renewable energy, once were polluted, it would be difficult to restore. The principle of using water is: classification and decontamination cycle use, Now the application technology includes: classification supply, water treatment technology, rain water collection circulation use and so on.

2.4 The application of bio-technique

There is very large development space of biotechnology in building and view environment. It is the key to link of circulation reuse and environmental pollution. Using bio-technique can save the energy, turn waste into wealth, also can minimize the environmental pollution. So, it should be considered at the beginning of design.

3. CONCLUSION

“The more progressed of the science and the art, the more scientific the art would take, the more artistic the science take; The two say good-bye at the bottom of the tower, join in the top of the tower ”. The architecture is also. Now, it is the time to tie in the science and the art together. For a long time, the artistry of the building was more considered by most architects, but not the technology. Today, the time requires us to accomplish " sustainable development ". So the technology has been more and more as important as art in architecture design.

Louis Henry Sullivan had said, “Form follows function” in designs. In the human-oriented today, we should conduct " form follows people's demand " People need sustainable development, the technology support sustainable development of architectures. So, we must call for renewable-energy-technology using, and make sure the perfect combination of renewable energy and architecture design.

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